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A Randomized Complete Block Design Study to Evaluate the Effectiveness of Humic Acid on Growth and Productivity *Thymus vulgaris* L.

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Thymus vulgaris is a versatile plant with various medical and pharmaceutical applications. Thyme has significant antioxidant and antimicrobial properties, and the leaf oil extract shows various medicinal and therapeutic effects. The type of fertilizer and the method of its application can affect the growth and productivity of the thyme crop, which affects the essential oil content. In order to know the effect of humic acid on the growth and productivity of common thyme, a field experiment was conducted in the Qutaylibiyah area, Jableh, Syria, during the agricultural season 2023-2024. The spraying was done with three concentrations of potassium humate solution with the trade name POWHUMUS® WSG 85, which contains 60% humic acid. The experiment was designed according to a randomized complete block design (RBCD) with five replicates for each treatment. The results of the study showed a significant effect of humic acid on all the studied traits. The 200 mg. L^{-1} concentration was significantly superior to the rest of the concentrations in the traits of plant height (28.15 cm), fresh weight (42.50 g), dry weight (11.75 g), and vegetative production (5.05 tons/ha), the percentage of Essential oil in the leaves (5.75%), and the concentration of 100 mg. L^{-1} was

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significantly superior to the control in all the studied characteristics. The study recommends the importance of using humic acids in improving the growth and productivity of medicinal and aromatic plants.

Keywords: Humic acids; thyme; growth; production.

1. INTRODUCTION

Thymus vulgaris is one of the most famous medicinal and aromatic plants that belong to the Lamiaceae family. It grows in the northern part of the western Mediterranean region [1]. Essential oils are found in all parts of the plant, but they are found in concentrated form in flower buds, the most important compound in the essential oil is thymol [2]. Thyme is an aromatic and medicinal plant with antioxidant, antimicrobial, and antifungal properties, and is very important in the pharmaceutical and food industries. Essential oils are rich in phenolic compounds and possess a wide range of biological and pharmacological properties [3], and have antiseptic, carminative, antimicrobial and antioxidant effects [4].

Humic acid is a natural organic compound formed from the decomposition of organic materials in the soil [5]. Humic substances represent an essential component of soil structure and greatly affect its properties such as pH, availability of water and nutrients and cation exchange capacity. Humic acid affects various physiological processes and photosynthesis in plants [6]. Adding humic acids to soil leads to improving its chemical and physical properties [7]. Low organic matter content in the soil is a very serious problem, as the lack of organic matter in the soil makes it unsuitable for plant growth and development. Here the importance of adding humic acid to the soil is highlighted, as adding it to the soil is the most effective [8]. Humic acid is one of the most active compounds in soil [9]. The use of humic and fulvic acid improves the physical, biological and chemical properties of the soil, which leads to increased availability of nutrients to plants, improves the quality of fruits, improves soil fertility, and reduces diseases transmitted by soil [10,11,12]. Adding humic acid to the soil is very important in increasing its content of absorbable nutrients, which improves the chemical properties of the soil and increases plant growth and productivity [13].

Field experiments were conducted to study the effect of foliar spraying with humic acid at three concentrations (0, 100, and 200 mg. L^{-1}) on the growth and productivity of thyme plants. *Thymus vulgaris* L. The results showed that plant height, fresh weight, and oil seed percentage were significantly affected by foliar spraying with humic acid. Foliar spraying with humic acid at a dose of 200 mg. L^{-1} resulted in stronger growth and an increase in vegetative production and oil percentage [14].

In a study to investigate the effect of spraying with humic acid on some physiological and biochemical traits of *Thymus vulgaris*, three levels of humic acid solution (0, 200, 400 mg. L^{-1}) were applied. The application of humic acid had a significant effect on increasing plant height, fresh weight, and dry weight, with the highest recorded values at 26.15 cm, 68.53 g, and 25.41 g respectively when adding 400 mg/l of humic acid [15].

In a study on the effect of humic acid on the growth and productivity of common oregano (*Origanum vulgare* L. subsp. *hirtum*), three doses of humic acid (0, 30, 50 $L.ha^{-1}$) were applied. The fresh weight, dry weight, and leaf productivity were higher when applying the rate of 50 $L.\ ha^{-1}$ [16], and the fresh and dry weights of plants, as well as the rates of essential oils in *Origanum syriacum* L., increased with the concentration of humic acid [17,18-20]. The importance of the research Arising from the importance of organic acids in obtaining natural and environmentally friendly production, in addition to the nutritional, medical, and economic importance of arugula, and to meet the increasing demand of local markets for this plant, and due to the scarcity of academic research on it. This study aimed to determine the effect of using humic acid on the growth and productivity of common thyme.

2. MATERIALS AND METHODS

2.1 Research Site

The research was carried out in the Qatilibiyah region - Latakia Governorate (Fig. 1) during the 2022/2023 agricultural season.

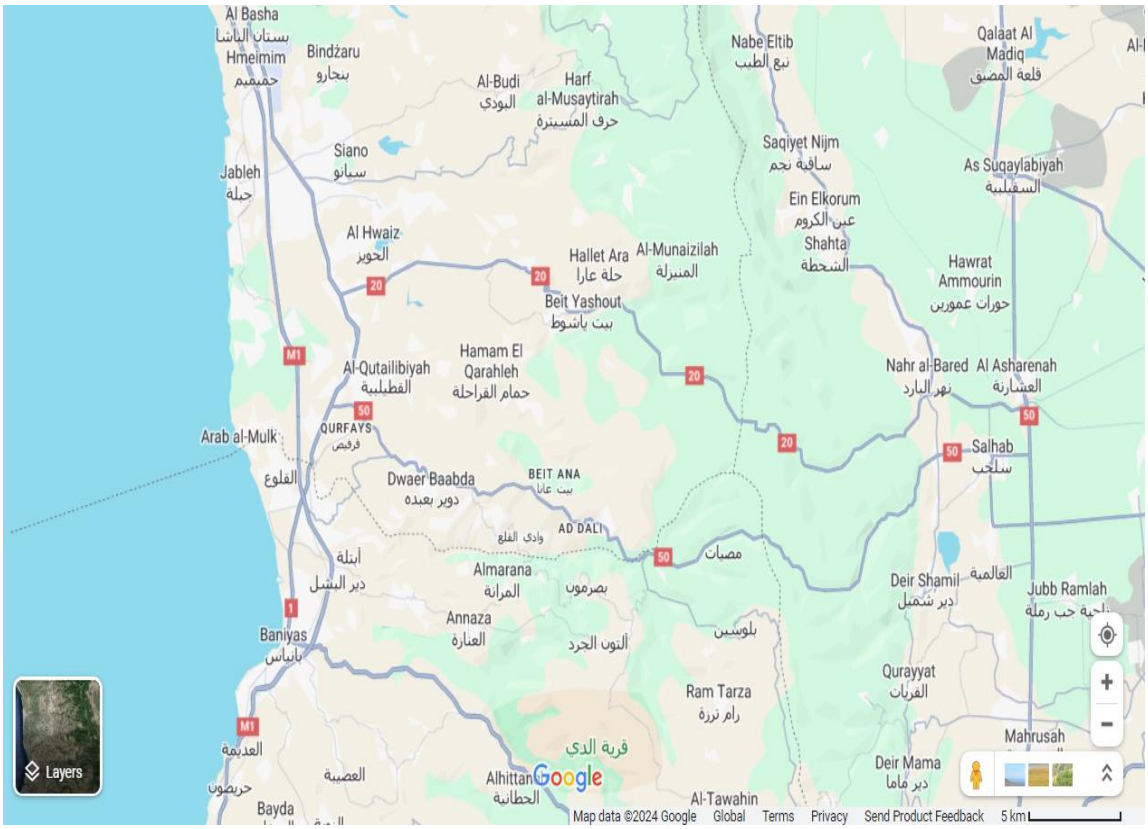

Fig. 1. Research site

2.2 Plant Material and Preparation of Site Soil

Healthy, homogeneous common thyme seedlings, 10 cm long, were obtained from one of the private nurseries in the Qatilibiyah region, and planted in lines within the experimental units, with a distance of 50 cm between the lines and another 30 cm between the plants. In one line. All service operations were carried out on time according to the needs of the plants. A specific amount of organic fertilizer was added estimated at 1 ton. ha^{-1}. The experiment was designed according to a randomized complete block design (RBCD) and with five replicates for each treatment. Spraying was applied with potassium humate with the trade name POWHUMUS® WSG 85, which contains 60% humic acid, and with three Concentrations (0, 100, and 200 mg. L^{-1}) according to the manufacturer's recommendations. The following Indicators were taken:

- Plant height (cm): Plant height was measured at the pre-flowering stage with a height measuring tape [21].
- Plant fresh weight (g): The plant was cut at the beginning of flowering at the soil surface level and weighed directly using a sensitive balance.
- Dry weight of the plant (g): The dry weight was determined after drying the plant in the oven at 65 degrees for 48 hours until the weight stabilized [22].
- Essential oil content in the leaves (%): The percentage of fixed oil was estimated by the Soxhelt method according to [23], where 10 g of leaf powder is taken to extract the oil using 100 ml of the organic solvent hexane by heating at a temperature of 60-80° Celsius for a period of 4-5 hours using the Soxhelt device with continued heating until the organic solvent evaporates completely. Then the crucible is dried in the oven at 105 degrees Celsius until the weight is constant, after which the percentage of oil is calculated.
- Leaf production in tons. ha^{-1}: Leaves were collected from an area of 1 m^2 from each experimental plot and weighed using a sensitive balance. Then the average coefficients were taken and attributed to hectares.

Table 1. Physical and chemical analyzes of the soil of the experimental field

Mechanical analysis			EC	PH	Caco3%	K	P	N
Clay%	Silt%	Sand%	decimens/m			mg/kg	mg/kg	mg/kg
39	32	33	.18	7.20	18.00	188.00	27.00	35.00

2.3 statistical Analysis

Statistical analysis was performed using CoStat version 6.400 software, and comparison between averages was made using L.S.D 5%.

Table 1 shows the results of physical and chemical analyzes of the soil of the experimental field, and it is clear that the soil has a moderate content of major elements and organic matter, moderate acidity, and low salinity.

3. RESULTS AND DISCUSSION

3.1 Response of Thyme Plant Height to Humic Acid

Plant height was significantly affected by spraying with humic acid (Table 2). Increasing the concentration of humic acid led to an increase in plant height. The plant reached its highest height (28.15 cm) when sprayed with a concentration of 200 mg. L^{-1}, compared to the lowest height in the control treatment (17.75 cm), and this can be explained by the stimulating effect of humic acid on plant growth, as adding humic acid to the soil improves the absorption of nutrients by the plant, and it also contains an excellent percentage of nitrogen that is easily absorbed by the plant, which leads to improved plant growth, and he noted many researchers reported similar results with these results, including [14 and 15] on thyme.

3.2 Response of Thyme Fresh Weight to Humic Acid

The fresh weight of the plant was significantly affected by spraying with humic acid (Table 2). Increasing the concentration of humic acid led to an increase in the fresh weight of the plant. The plant reached its maximum fresh weight (42.50 g) when sprayed with a concentration of 200 mg. L^{-1}, compared to the lowest fresh weight in the Control treatment (26.10 g). This can be explained by the essential role of organic humic acids in increasing the growth, development and division of plant cells, which leads to an increase in the fresh weight of the plant. Many researchers have indicated similar results with these results, including [14] and [15] on thyme.

3.3 Response of Thyme dry Weight to Humic Acid

The dry weight of the plant was significantly affected by spraying with humic acid (Table 2). Increasing the concentration of humic acid led to an increase in the dry weight of the plant. The plant reached its maximum dry weight (11.75 g) when sprayed with a concentration of 200 mg. L^{-1}, compared to the lowest dry weight in the Control treatment (7.35 g). The reason for the increased plant growth is attributed to the role of humic acid in increasing the effectiveness of basic biological and physiological processes in the plant, such as respiration and photosynthesis, and thus increasing the accumulation of dry matter. Many researchers indicated similar results with these results, including [15] and [17].

3.4 Response of Thyme Vegetative Production to Humic Acid

The vegetative production of the plant was significantly affected by spraying with humic acid (Table 3). Increasing the concentration of humic acid led to an increase in production. The maximum vegetative production reached (5.05 tons. ha^{-1}) when spraying with a concentration of 200 mg. L^{-1}, compared to the lowest vegetative production in the control treatment (4.15 tons. ha^{-1}), due to the important effect of humic acid in increasing the rate of absorption of nutrients and increasing the permeability of the cell membrane, which reflects positively on increasing plant production in quantity and quality. Many researchers indicated similar results with these results, including [17] on *Origanum vulgare*.

3.5 Response of Thyme Essential Oil Content to Humic Acid

The essential oil content of leaves was significantly affected by spraying with humic acid (Table 3). Increasing the concentration of humic acid led to an increase in oil content. The maximum oil content reached (5.75%) when spraying at a concentration of 200 mg. L^{-1}, compared to the lowest oil content in the treatment. The control (4.30%) is due to the

Table 2. The effect of humic acid on plant height, wet weight, and dry weight

Concentration of potassium humate (mg. L-1)	plant height (cm)	fresh weight (g)	dry weight (g)
0	4.15 c	4.30 c	7.35 c
100	4.55 b	5.05 b	9.50 b
200	5.05 a	5.75 a	11.75 a
L.S. $D_{5\%}$	0.35	0.52	1.78

Means followed by the different letter are significantly different at at 5%

Table 3. The effect of humic acid on vegetative production and percentage of essential oil

Concentration of potassium humate (mg. L-1)	Vegetable production (tons. ha-1)	oil content (%)
0	4.15 c	4.30 c
100	4.55 b	5.05 b
200	5.05 a	5.75 a
L.S. $D_{5\%}$	0.35	0.52

Means followed by the different letter are significantly different at 5%

important effect of humic acid in increasing the level of metabolic and metabolic processes in the plant, which leads to an increase in the products of secondary metabolism, including oil. Many researchers indicated similar results with these results, including [14] on thyme.

4. CONCLUSIONS

Foliar spraying with humic acid led to a significant increase in the studied growth and productivity traits of the common thyme plant. The effect increased with an increase in the concentration of humic acid, and the concentration of 200 mg. L^{-1} achieved the highest averages in all the studied traits. Therefore, we recommend using humic acid to fertilize the common thyme and replace it with fertilizers. Chemicals that are not devoid of side effects on humans and the environment.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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